

Customer No.: 31561
Docket No.: 13605-US-PA
Application No.: 10/711,678

REMARKS

Present Status of the Application

Claims 1-3, 5-11 and 13-22 are rejected under 35 U.S.C. 103(a), as being unpatentable over Nishizawa (U.S. 66,136,86) in view of Autryve (5,935,877). Applicants have amended claim 21. After entry of the foregoing amendments, claims 1-3, 5-11 and 13-22 remain pending in the present application, and reconsideration of those claims is respectfully requested.

Interview Summary

The undersigned would like to thank Examiner Ghyka for granting a telephonic interview on November 8, 2006 during which the matter of the obviousness rejections based on an overlapping range of the power disclosed by Autryve ('877) was discussed. More particularly, the undersigned and the examiner discussed the particular range of plasma power disclosed in the present invention achieved unexpected results relative to the prior art range. After discussing this matter, the examiner agreed that overlapping of ranges with the prior art is unobvious if that particular range is critical and recommended a submission of evidence of criticality of the claimed range.

Customer No.: 31561
Docket No.: 13605-US-PA
Application No.: 10/711,678

Discussion of Office Action Rejections

The Office Action rejected claims 1-3, 5-11 and 13-22 under 35 U.S.C. 103(a), as being unpatentable over Nishizawa (U.S. 6613686) in view of Autryve (5935877).

Applicants respectfully traverse the rejections for at least the reasons set forth below. The present invention is directed to patterning method for reducing the condense defect when the patterned photoresist layer is etched at low temperature. Applicants respectfully assert that Nishizawa in view of Autryve is legally deficient for the purpose of rendering claims 1 and 20 unpatentable for at least the reason that not every element of the claim was taught or suggested by cited references such that the invention as a whole would have been obvious to one of ordinary skill in the art.

The present invention specifically teaches "etching the film by performing an anisotropic plasma etching process with a power applied at one electrode in a range of about 150W to about 300W for generating a field" as taught in claim 1 and "etching the film by performing an anisotropic plasma etching process with a power applied at one electrode in a range of about 150W to about 300W for generating a field using a plasma sources containing a perfluorinated chemical and a partially fluorinated chemical supplied at a gas flow ratio of larger than 1" as taught in claim 20.

The technical significant of the foregoing limitations is that the anisotropic plasma etching process includes a power applied at one electrode in a range of about 150W to about 300W for generating a field. The power brings high bombardment ions and thereby the condense

Customer No.: 31561
Docket No.: 13605-US-PA
Application No.: 10/711,678

defect owing to etching the patterned photoresist layer at low temperature can be removed. Furthermore, the iso-dense loading effect is improved.

Nishizawa provides a method of etching silicon nitride film and method of producing semiconductor device to restrain the formation of copper fluorides when removing a stopper film comprising a silicon nitride film formed on copper interconnects. Autryve provides a plasma process for an insulating layer, such as silicon dioxide, overlaying a silicon surface. Autryve mentions that the power level of the plasma may vary from about 300 W to about 5KW (see col. 7, line 12-39), rather than about 150W to about 300W of the claimed invention. Neither Nishizawa or Autryve teach the condense defect relates to the power applied in the anisotropic plasma etching process. Therefore, there is no motivation for people skilled in the art to combine Nishizawa and Autryve to solve the problem of condense defect when the patterned photoresist layer is etched at low temperature. Nishizawa in view of Autryve fails to teach or suggest "etching the film by performing an anisotropic plasma etching process with a power applied at one electrode in a range of about 150W to about 300W for generating a field" of the claimed invention.

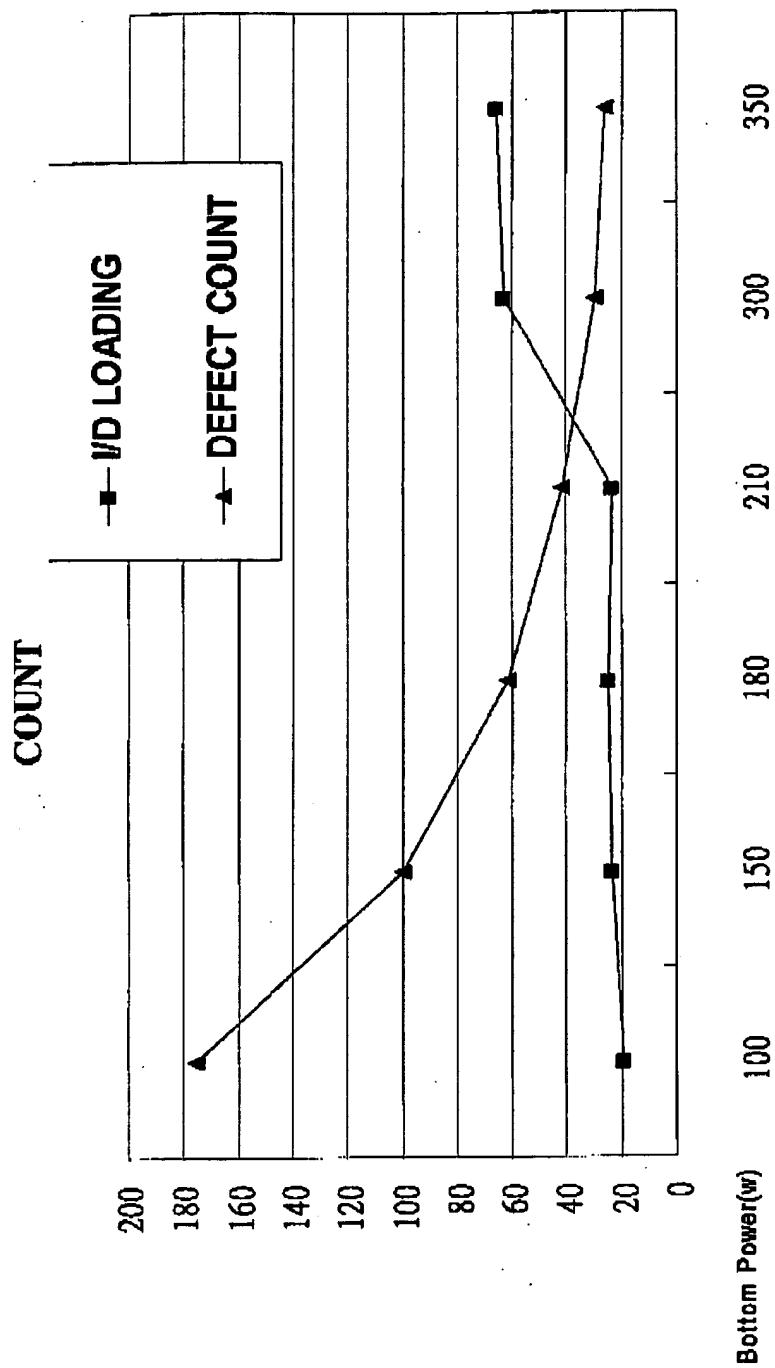
Furthermore, according to our experiment, the range of the power level of the plasma is very important for the etching process to reduce condense defect. If the power level of the plasma is higher than 300W, the iso-dense critical dimension bias is increased, leading to increase the iso-dense loading effect as shown in below. On the other hand, if the power level of the plasma is lower than 150W, the total defect count is very high as shown in below, so that the condense defect can not be overcame. The below pictures illustrate kill defects generated in the

Customer No.: 31561
Docket No.: 13605-US-PA
Application No.: 10/711,678

patterning process when the power applied at one electrode is 100W. The kill defect may cause a failure of the operation of the semiconductor structure. Only controlling the power in a range of about 150W to about 300W can reduce condense defect and improve iso-dense loading effect. Therefore, the claimed invention has an unexpected result and therefore the claimed invention is not obvious.

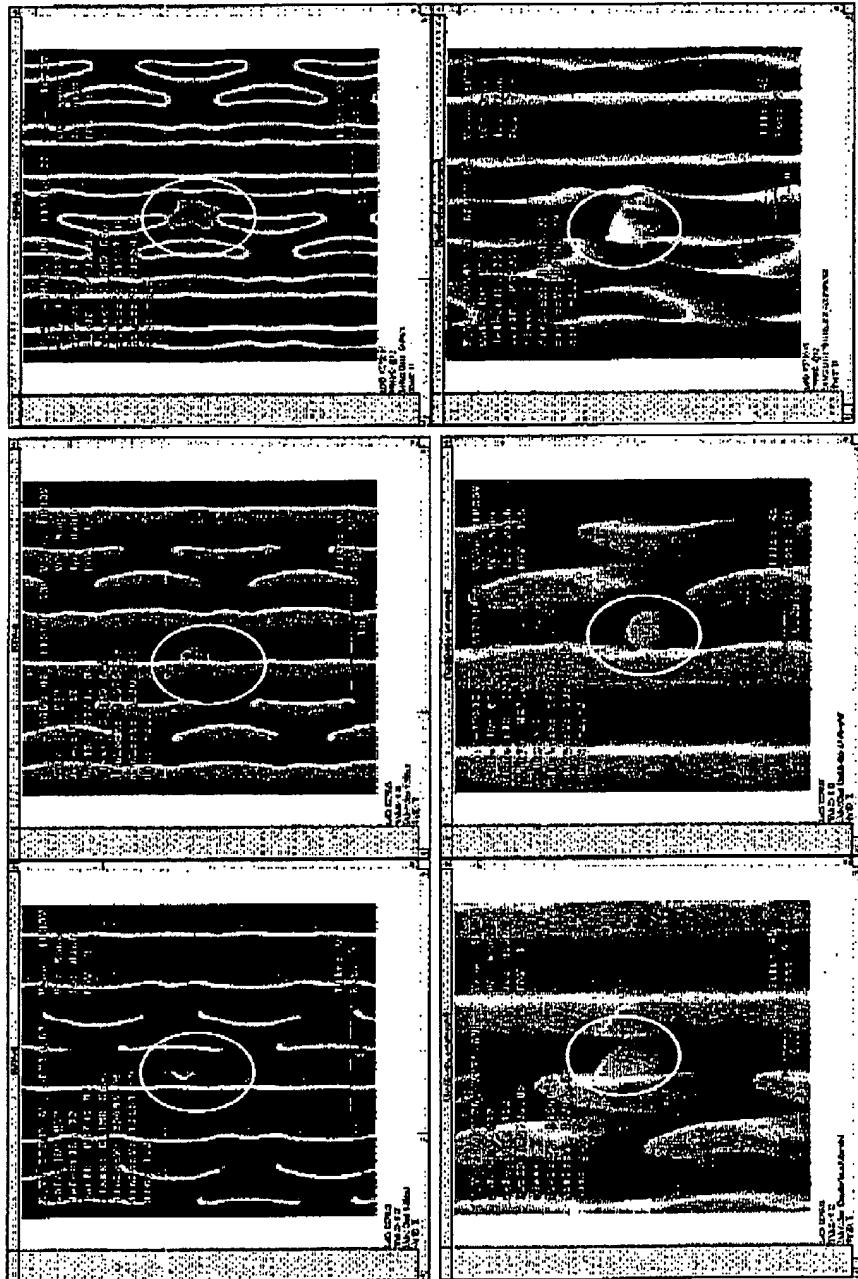
Customer No.: 31561
Docket No.: 13605-US-PA
Application No.: 10711,678

S BOTTOM POWER VS. ID LOADING & DEFECT



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Customer No. 31561
Docket No.: 13605-USPA
Application No.: 10/711,678



Page 10 of 13

Customer No.: 31561
Docket No.: 13605-US-PA
Application No.: 10/711,678

Another technical significant of the foregoing limitations is that the film is etched by performing an anisotropic plasma etching process using a plasma sources containing a perfluorinated chemical and a partially fluorinated chemical supplied at a gas flow ratio of larger than 1 at a temperature range of about -50°C to about 50°C. When the field applied at the plasma is stronger, the deposition of the by-products of the plasma is unexpectedly increased, especially in the dense region. By adjusting the plasma source in the etching step, generation of the by-products of the plasma may be reduced. If the proportion of the partially fluorinated chemical is too high, the etching process will produce more polymer defect, the patterned profile will varied and the iso-dense loading effect is increased. Therefore, the lower the proportion of the partially fluorinated chemical and the higher of the perfluorinated chemical can prevent the production of the polymer defect, control the patterned profile and reduce the iso-dense loading effect.

The object of the Nishizawa is to provide an etching method that restrains the formation of copper fluorides when removing a stopper film comprising a silicon nitride film formed on copper interconnects. Nishizawa discloses CF₄ and CHF₃ at flow rates in a ratio of 7:3 resulting in large amount of the unwanted copper fluoride (see Table 1, Experiments No. 1 and 2). In order to restrain the formation of copper fluorides, Nishizawa teaches using a mixture of fluorocarbon gas and an inert gas as the reaction gas, in which the fluorocarbon gas contains both CF₄ and CHF₃ supplied at flow rates in a ratio of 3:7 to 0:1. That is, CF₄ and CHF₃ are supplied at flow ratio of lower than 1, not encompasses the presently claimed ratio. Therefore, Nishizawa

Customer No.: 31561
Docket No.: 13605-US-PA
Application No.: 10/711,678

teaches away the claimed invention. Furthermore, the objects of Nishizawa and Autryve are different from that of the present invention, therefore there is no motivation for people skilled in the art to modify Nishizawa and to combine modified Nishizawa and Autryve to solve the problem of condense defect when the patterned photoresist layer is etched at low temperature.

In light of the amendment and the foregoing discussion, claims 1 and 20 are not anticipated by prior art and are believed to be patentably distinguished from the cited art so that the reconsideration and withdrawal of the Office Action's rejection to claims 1 and 20 under 35 U.S.C § 103 are respectfully requested.

Dependent claims 2-3, 5-11, 13-19 and 21-22 are submitted to be patentably distinguishable over the prior art of record for at least the same reasons as independent claims 1 and 20 from which these claims respectively depend, as well as for the additional features that these claims recite. Accordingly, Applicants request that the Section 103 (a) rejection to claims 1-3, 5-11 and 13-22 be withdrawn.

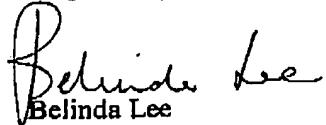
Customer No.: 31561
Docket No.: 13605-US-PA
Application No.: 10/711,678

CONCLUSION

For at least the foregoing reasons, it is believed that the pending claims 1-3, 5-11 and 13-22 are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

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Respectfully submitted,


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Page 13 of 13